August 5, 2013

Union Carbide Corporation
A Subsidiary of The Dow Chemical Company
PO Box 8361
3200/3300 Kanawha Turnpike
South Charleston, WV 25303
U S A

Mr. William Wentworth
U.S. Environmental Protection Agency Region 3
1650 Arch Street
Philadelphia, PA 19103-2029

RE: *Environmental Investigation Results*
Former Rehabilitation Center Property at West Virginia State University
Institute, West Virginia

Dear Mr. Wentworth:

Attached please find the technical memorandum (memo) for the above-referenced property. The memo summarizes the results of the environmental investigation conducted on behalf of Bayer CropScience by Union Carbide Corporation (UCC), at the former Rehabilitation Center Property (now owned by West Virginia State University) at Institute, West Virginia. The original analytical laboratory reports, site figures, and soil boring and well construction logs are also attached.

If you have any questions, please call me at (304) 747-7788. Thank you for assistance in this matter.

Sincerely,

Jerome E. Cibrik, PG
Remediation Leader

Attachments

cc: Melvin Jones/West Virginia State University
Ruth Prince/USEPA
Cathy Guynn/West Virginia Department of Environmental Protection
Robert Lockemer/Bayer CropScience (electronic only)
Chintan Amin/Bayer CropScience (electronic only)
Connie Stewart/Bayer CropScience
Greg Coffey/Bayer CropScience (electronic only)
Jonathan Raess/Union Carbide Corporation (cover letter only)
Marianne McClure/Union Carbide Corporation (cover letter only)
Trish Thompson/Union Carbide Corporation (electronic only)
Kylie McCord/CH2M HILL

East Property Boundary Investigation at West Virginia State University, Bayer CropScience Institute Facility, Institute, West Virginia

PREPARED FOR: Union Carbide Corporation (UCC)

PREPARED BY: CH2M HILL

DATE: August 5, 2013

1 Introduction

This technical memorandum documents the results of an investigation to determine if constituents of concern (COCs) in groundwater have migrated from the Bayer CropScience Institute Facility (Institute facility) beneath the West Virginia State University (WVSU) property located in Institute, West Virginia (Figure 1). The WVSU property identified in this evaluation was transferred from the West Virginia Department of Administration (WVDA) in May 2013; therefore, it should be noted that access agreements for investigation activities were made with WVDA, the property owner at the time. The 433-acre Institute facility is currently used for various industrial chemical manufacturing processes and as a warehouse distribution center.

Historically, volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) have been detected in shallow and deep groundwater monitoring wells on the Institute facility located adjacent to the WVSU western property boundary. Available data indicate that groundwater is potentially flowing from the Institute facility towards the WVSU property and suggest the potential for contaminants on the Institute facility to migrate to the WVSU property. Therefore, a site investigation was conducted to determine if migration of contaminants to the WVSU property has occurred.

2 Objectives

The objectives of the investigation completed on the WVSU property were to:

- Determine if VOCs and SVOCs detected in wells along the Institute facility's eastern property boundary have migrated beneath the WVSU property;
- Define groundwater flow direction on the WVSU property; and
- Evaluate potential exposure to COCs in groundwater via the two identified relevant exposure pathways:
  - Drinking water use (i.e., ingestion, dermal contact, and inhalation); and

- Vapor intrusion (VI) (i.e., inhalation of VOCs that volatilize from the groundwater, migrate upward through the soil pore space, and then have the potential to enter overlying or nearby structures).

3 Constituents of Concern

To evaluate the potential for VOCs and SVOCs in groundwater to have migrated onto the WVSU property, analytical results from four upgradient monitoring wells on the Institute property (TW-65A/B and VW-03A/B) were reviewed for detected constituents. Analytical data Tables 1 and 2 list the 13 VOCs and two SVOCs detected in the upgradient wells. These constituents were identified as COCs for the investigation effort conducted on the WVSU property.

VOCs and SVOCs detected in samples collected at the WVSU property were compared to the applicable groundwater screening criteria:

- Maximum contaminant levels (MCLs) (USEPA 2009), where available; or
- U.S. Environmental Protection Agency (USEPA) Regional Screening Levels (RSLs) (USEPA 2013a) for tap water based on a target carcinogenic risk = 1E-06 and a target non-cancer hazard quotient (HQ) = 0.1, when no MCL is available; and
- USEPA Vapor Intrusion Screening Levels (VISLs)[1] (USEPA 2013b) for residential and commercial/industrial exposure scenarios based on a site-specific groundwater temperature of 19 degrees Celsius (°C). Although current and potential future use of the property is not expected to be residential, based on discussions with WVSU on July 11, 2013, VISLs based on this exposure scenario are presented for discussion purposes in order to evaluate all potential reuse opportunities. It is also important to note that only the shallowest groundwater samples at each sampling location were compared to VISLs because these samples are more representative of groundwater concentrations at the water table where groundwater interacts with soil vapor and influences the VI pathway.

4 Summary of Investigation Activities

Groundwater sampling locations on the WVSU property were selected based on the following criteria: location (downgradient or sidegradient) relative to Institute wells TW-65A/B and VW-03A/B, accessibility, utility clearance, and spatial distribution on the WVSU property. Four temporary monitoring wells were installed to obtain sufficient water level information to determine groundwater flow on the WVSU property. The investigation locations are shown on Figure 2.

The work conducted to satisfy the investigation objectives took place between March and May 2013, and included the following activities:

- Conduct utility locates and air knifing to identify and protect subsurface utilities;

[1] These comparisons are presented according to USEPA criteria only, and do not represent any medical opinion.

- Collect continuous soil cores from ground surface to the top of bedrock at five locations using direct-push technology (DPT) drilling equipment;
- Collect two groundwater grab samples (one shallow and one deep) at each of the five locations using the DPT equipment;
- Install temporary piezometers within four of the five DPT locations to collect water levels and additional groundwater samples;
- Survey soil borings and temporary monitoring wells for northing, easting, and ground surface elevations; and
- Characterize and manage investigation-derived waste (IDW).

In addition to reviewing historical groundwater information on the Institute facility, CH2M HILL contracted with Environmental Data Resources (EDR) (Milford, Connecticut) to perform an environmental database and aerial photography search of the WVSU property. The purpose of the EDR review was to determine if any evidence of facilities, operation, activities, or management of waste on the WVSU property or on nearby and adjacent properties may have resulted in the release of COCs to the environment. Review of the EDR report and historical aerial photographs did not identify any activities that may have resulted in the release of COCs on or near the WVSU property.

4.1 Utility Protection

Prior to intrusive work, each boring location was cleared for utilities using the following techniques:

- Each soil boring/temporary piezometer location was marked.
- The West Virginia "one call" (811) utility service and West Virginia American Water Company were contacted to conduct a joint meeting on March 8, 2013.
- A private utility locate was completed at each proposed location by Underground Detectives on March 8, 2013.
- Each borehole was also cleared of utilities using an air knife to a depth of 5 feet below ground surface (bgs).

4.2 Direct-Push Soil Core Collection

Continuous soil cores were collected from the ground surface to the top of bedrock (approximately 50 feet bgs) using a DPT drill rig at each of the five locations on the WVSU property. The soil cores were collected in dedicated, 2-inch-diameter, 5-foot-long acetate liners, and lithological descriptions were recorded. The lithological descriptions then were used to determine the depths at which to collect groundwater grab samples. Soil was also inspected for impacts using visual methods and a photoionization detector (PID). Based on an absence of visual impacts and no elevated PID readings, no soil samples were collected for analysis. The soil boring logs are presented in Attachment 3.

4.3 Groundwater Grab Samples

Two groundwater grab samples were collected from each boring location in March 2013, including one from the shallow portion of the aquifer and the other from the deep portion. Groundwater was first observed at depths of 27 to 35 feet bgs. The shallow groundwater samples were collected at depths between 32 and 37 feet bgs (within approximately 10 feet of the top of the water table), and each of the deep groundwater samples was collected from 42 to 47 feet bgs (approximately 3 to 8 feet above bedrock).

Groundwater grab samples were collected by driving a retractable, 4-foot-long stainless steel screen to the targeted groundwater sampling depth. Dedicated polyethylene tubing fitted with a check valve was lowered through the drill pipe to just above the base of the screened interval. The tubing then was repeatedly raised and lowered quickly in short strokes throughout the length of the screened interval to move groundwater up and out of the tubing. After each groundwater sample was collected, the drill rods and stainless steel screen were decontaminated before their next use.

Samples were analyzed for COCs (Section 3) using USEPA Methods SW8260B (VOCs), SW8270 (SVOCs), and SW8270C Selected Ion Monitoring (SIM) for 1,4-dioxane. The samples were collected in laboratory-supplied bottles, stored on ice, and shipped by courier using chain-of-custody procedures to Microbac Laboratories, Inc. in Marietta, Ohio. Analytical results are included in Tables 1 and 2 for shallow and deep samples, respectively. Data are compared to applicable screening criteria as detailed in Section 1. Attachment 1 presents the laboratory reports for groundwater samples. The analytical data were uploaded to the data warehouse and validated. A copy of the validation memorandum is provided in Attachment 2.

4.4 Temporary Piezometer Well Installation

Following the collection of groundwater grab samples, four piezometers were completed onsite in March 2013 at boring locations INS-0387, INS-0388, INS-0389, and INS-0390 to determine the groundwater flow pattern on the WVSU property. Each piezometer was installed to approximately 45 feet bgs, with a 10-foot screen and the following components:

- 1-inch schedule 40 polyvinyl chloride (PVC) risers affixed with 10-foot screens (10-slot);
- # 5 global sand (filter pack) annulus from the total well depth to 1 foot above the top of screen;
- 2 feet of hydrated bentonite chips above the filter pack to serve as the plug;
- Hydrated bentonite chips or bentonite powder above the plug to within 3 feet of ground surface (sand or native backfill to ground surface); and
- J-plug and lock for the well, and a temporary surface completion consisting of a road box.

Piezometer construction logs are included in Attachment 3.

4.4.1 Water Level Measurements

Static water levels were measured at each of the temporary piezometers four times from March to May 2013 using an oil/water interface probe (Figures 2 and 3, respectively, show the results from the April 17 and May 24 gauging events). Depths to water ranged from 18.79 feet bgs at INS-0387 to 22.96 feet bgs at INS-0390. Static water levels were also measured at Institute wells TW-65A/B and VW-03A/B.

4.4.2 Temporary Piezometer Sampling

Groundwater samples were collected from each of the temporary piezometers on May 16-17, 2013, for the purpose of obtaining data to verify the VOC concentrations in grab samples. Groundwater samples were collected using bailers and analyzed for VOCs only. Each groundwater sample was shipped, analyzed, and then validated as described in Section 4.3. The results are summarized in Table 2. Attachment 1 presents the laboratory reports for groundwater samples and Attachment 2 provides the validation memorandum.

4.5 Surveying

Following installation of the temporary piezometers, the five soil boring locations and casing elevations for the four temporary piezometers were surveyed using a Leica System 1200 global positioning system (GPS) Smart Rover. The GPS data were collected on March 20, 2013, and uploaded to the data warehouse.

4.6 Temporary Piezometer Abandonment

The four temporary piezometers were abandoned in place on July 10, 2013, in accordance with Section 19.3.b of the West Virginia Department of Environmental Protection (WVDEP) Regulation 47 CSR 60, *Monitoring Well Design Standards*. Bentonite chips or pellets, less than 0.5 inches in diameter, were placed downhole and hydrated. The upper 3 feet of casing was removed and backfilled using native soil and compacted.

4.7 Investigative-Derived Waste

Four drums of IDW (two groundwater, one soil, and one personal protective equipment [PPE]) were generated during the March 2013 investigation. One soil and one groundwater waste characterization sample were collected and submitted for analysis of VOCs, SVOCs, and total Resource Conservation and Recovery Act (RCRA) metals. Samples were analyzed using methods identified in Section 4.3 for VOCs and SVOCs, USEPA Method 6010B (arsenic, barium, cadmium, chromium, lead, and silver), USEPA Method 6020 (selenium), and USEPA Method 7470A (mercury). Based on a review of the analytical results, all four drums were characterized as nonhazardous.

All waste was transported offsite following the work and disposed of in accordance with state and federal regulations. Attachment 1 presents the laboratory reports for the IDW samples.

5 Investigation Results

Five soil borings were advanced on the WVSU property in March 2013. The geology in the investigation area consists of fill (reworked silt, sand, and clay) from the ground surface to approximately 15 feet bgs. At soil boring locations INS-0387 and INS-0388, fly-ash material

was observed intermittently within the fill material from 5 to 13 feet bgs. The fill is underlain by native silty to sandy clay to approximately 28 feet bgs. Fine-grained sand lies beneath the clay and terminates at the sandstone bedrock surface at approximately 50 feet bgs. The geology on the WVSU property is similar to that observed on the adjacent Institute property. Boring logs are presented in Attachment 3.

Four rounds of water levels were collected from March to May 2013, and results were consistent between each event. Groundwater flow on the WVSU property is generally to the southeast, toward the Kanawha River, and is consistent with the flow direction observed at the western property boundary of the adjacent Institute facility.

Fourteen groundwater samples and two field duplicates (FDs) were collected from the WVSU property between March and May 2013. Samples were collected from boreholes or from temporary piezometers. No soil samples were collected during this investigation due to the absence of suspected impacts based on field PID readings and visual observation of the soil cores.

Analytical data are presented in Tables 1 and 2, and compared to applicable screening criteria as detailed in Section 3, above. VISLs, included in Table 1 in comparison to the shallow groundwater data, are presented at two target risks due to the inherent uncertainty in evaluating the VI pathway with groundwater data alone:

1. A target carcinogenic risk = 1E-06 / target non-cancer HQ = 0.1;
    a. Representing the low end of USEPA's risk management range for carcinogenic endpoints of 1E-06 to 1E-04, as is most often appropriate in evaluating residential exposure scenarios; and
    b. The threshold hazard index (HI) = 1, adjusted by a factor of 10 to account for cumulative non-carcinogenic effects from multiple constituents.
2. A target carcinogenic risk = 1E-05 / target HQ = 1;
    a. Representing the midpoint of USEPA's risk management range for carcinogenic endpoints of 1E-06 to 1E-04, as is most often appropriate in evaluating commercial/industrial exposure scenarios; and
    b. The non-cancer threshold HI = 1.

Five groundwater grab samples were collected from the shallow portion of the aquifer (Table 1 and Figure 4) and compared to applicable screening criteria:

- The following VOCs were detected at concentrations above the associated MCL/RSL screening criteria in the shallow groundwater samples: 1,1-dichloroethane, 1,4-dioxane, and chlorobenzene;
- The following VOCs were detected at concentrations above residential VISLs based on a target carcinogenic risk = 1E-06 / target non-cancer HQ = 0.1: chloroform, chlorobenzene, and trichlorotrifluoromethane;
- Only chloroform was detected at a concentration greater than residential VISLs based on a target carcinogenic risk = 1E-05 / target non-cancer HQ = 1;

- Only chloroform was detected above commercial/industrial VISLs based on a target carcinogenic risk = 1E-06 / target non-cancer HQ = 0.1; and
- No constituents were detected above commercial/industrial VISLs based on a target carcinogenic risk = 1E-05 / target non-cancer HQ = 1.

Nine groundwater samples and two FDs were collected from the deep portion of the aquifer from five groundwater grab locations and four temporary piezometers (Table 2 and Figure 5). The VOCs 1,1-dichloroethane, 1,4-dioxane, benzene, chlorobenzene, dichlorodifluoromethane, and trichlorofluoromethane were detected at concentrations above the associated MCL/RSL screening criteria.

6 Conclusions and Recommendations

Based on a review of analytical data and water level data collected on the WVSU property and on the western property boundary of the adjacent Institute facility, it appears that COCs detected at the Institute facility may have migrated beneath the WVSU property.

Water levels collected from the four temporary piezometers indicate that groundwater flow is to the southeast, toward the Kanawha River.

Potential exposures due to COCs in groundwater at the WVSU property were evaluated for the two identified relevant exposure pathways: ingestion through drinking water and inhalation through VI into occupied buildings.

The drinking water pathway was assessed by comparing groundwater sampling results to USEPA MCLs/RSLs in both shallow and deep groundwater samples. Six constituents were reported at concentrations greater than associated MCLs/RSLs; however, there are no drinking water wells on the WVSU property and, therefore, there is no risk associated with ingestion through drinking water.

The inhalation pathway was assessed by comparing the shallow groundwater samples to residential and commercial/industrial VISLs based on two target risk values: carcinogenic risk = 1E-06 / target non-cancer HQ = 0.1; and carcinogenic risk = 1E-05 / target non-cancer HQ = 1. Results show:

- Three VOCs were detected at concentrations greater than residential VISLs based on carcinogenic risk = 1E-06 / target non-cancer HQ = 0.1;
- Chloroform was reported at a concentration greater than the associated residential VISL based on carcinogenic risk = 1E-05 / target non-cancer HQ = 1;
- Chloroform was also detected above commercial/industrial VISLs based on a target carcinogenic risk = 1E-06 / target non-cancer HQ = 0.1; and
- No VOCs were detected above commercial/industrial VISLs based on a target carcinogenic risk = 1E-05 / target non-cancer HQ = 1.

There are no currently occupied buildings in the area investigated on the WVSU property. In addition, during a meeting with Union Carbide Corporation (UCC) and Bayer CropScience on July 11, 2013, WVSU indicated it has no plans for residential reuse at this property.

The following are recommended:

- Place an environmental covenant on the WVSU property prohibiting the use of groundwater and requiring a vapor barrier for new buildings constructed on the property. This covenant will help ensure that groundwater is not used as a source of drinking water and that vapors will not migrate into future occupied buildings. There are currently no water wells on the WVSU property, which is supplied with drinking water by a public water supply.
- Place an environmental covenant on the WVSU property prohibiting residential reuse. Based on commercial/industrial land use, no constituents were detected above applicable VISLs at the midpoint of USEPA's risk management range (i.e., 1E-05); therefore, no further evaluation would be proposed.

7 References

CH2M HILL. 2009. *Current Conditions Report*. Union Carbide Corporation, Institute Facility, Institute, West Virginia.

U.S. Environmental Protection Agency (USEPA). 2009. *National Primary Drinking Water Regulations*. http://water.epa.gov/drink/contaminants/index.cfm/

U.S. Environmental Protection Agency (USEPA). 2013a. *Regional Screening Levels*. June. http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

U.S. Environmental Protection Agency (USEPA). 2013b. *Office of Soil Waste and Emergency Response (OSWER) Vapor Intrusion Assessment Vapor Intrusion Screening Level (VISL) Calculator*, Version 3.1. June.

Tables

1 Shallow Groundwater Data Compared to Screening Criteria
2 Deep Groundwater Data Compared to Screening Criteria

Figures

1 Site Map
2 Potentiometric Map - April 2013
3 Potentiometric Map - May 2013
4 Shallow Groundwater Analytical Results
5 Deep Groundwater Analytical Results

Attachments

1 Analytical Laboratory Reports (presented on CD)
2 DQE Validation Memorandum
3 Boring Logs and Piezometer Construction Logs

Tables

Table 1
Shallow Groundwater Data Compared to Screening Criteria
East Property Boundary Investigation at West Virginia Department of Administration Property Technical Memorandum
Bayer CropScience Institute Facility, Institute, West Virginia

				Location	INS-0385	INS-0387	INS-0388	INS-0389	INS-0390
				Sample ID	0385-GW01-031513	0387-GW01-031413	0388-GW01-031413	0389-GW01-031313	0390-GW01-031213
				Sample Depth (ft)	27 - 32	30 - 35	32 - 37	32 - 37	32 - 37
				Sample Date	3/15/2013	3/14/2013	3/14/2013	3/13/2013	3/12/2013
		Residential VI SL[b]		Commercial / Industrial VI SL[b]					
Analyte	**MCL/RSL[a]**	**1E-06 / 0.1**	**1E-05 / 1**	**1E-06 / 0.1**	**1E-05 / 1**				
SVOCs (ug/L)									
Isophorone	67	1.2E+06	1.2E+07	5.1E+06	5.1E+07	5.43 U	5.49 U	5.56 U	5.43 U	5.56 U
Naphthalene	0.14	6.2	62	31	310	5.43 U	5.49 U	5.56 U	5.43 U	5.56 U
VOCs (ug/L)									
1,1-Dichloroethane	2.4	8.5	85	43	4,300	3.29	1 U	1 U	1.88	2.67
1,1-Dichloroethene	7	24	240	100	1,000	1 U	1 U	1 U	1 U	1.45
1,2-Dichloroethane	5	2.6	26	13	130	1 U	1 U	1 U	1 U	1 U
1,4-Dioxane (p-Dioxane)	0.67	1,600	16,000	8,100	81,000	19.9	1.1 UJ	2.87 J	3.71 J	7.08 J
Acetone	1,200	2.9E+06	2.9E+07	1.2E+07	1.2E+08	5 U	5 UL	5 U	5 U	5 U
Benzene	5	1.8	18	9.2	92	1 U	1 U	1 U	1 U	1.76
Chlorobenzene	100	57	570	240	2,400	1 U	1 U	*165*	1 U	*64.8*
Chloroform	80*	0.91	9.1	4.6	46	*4.46*	1 U	1 U	1 U	***12.2***
Dichlorodifluoromethane	19	0.99	9.9	4.1	41	1 U	1 U	1 U	1 U	1 U
Ethylbenzene	700	4.3	43	22	220	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5	8	80	34	340	1 U	1 U	1 U	1 U	1 U
Toluene	1,000	2,600	26,000	11,000	110,000	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	110	23	230	95	950	8.55	1 U	1 U	3.64	*26.5*
VOCs, Total	--	--	--	--	--	36.2	0 U	167.87	9.23	116.46

Notes:

[a] Maximum Contaminant Level (MCL) (USEPA 2013a), where available, or USEPA Regional Screening Level (RSL) (USEPA 2013a) for tap water based on a target carcinogenic risk = 1E-06 and a target non-cancer hazard index (HI) = 0.1.

[b] USEPA Vapor Intrusion Screening Levels (VI SLs) (USEPA 2013b) based on a site-specific groundwater temperature of 19 degrees Celsius. Values for two exposure scenarios (residential and commercial / industrial) and two target risks (carcinogenic risk = 1E-06 / target non-cancer HQ = 0.1 [i.e. 1E-06 / 0.1/ and carcinogenic risk = 1E-05 / target HQ = 1 [i.e. 1E-05 / 1]) are provided.

*The listed MCL (80 ug/L) is applied to the sum of four trihalomethanes (bromodichloromethane, bromoform, dibromochloromethane, and chloroform) as an annual average as discussed in the National Primary Drinking Water Standards (USEPA 2009) available at: http://water.epa.gov/drink/contaminants/index.cfm#List. As only chloroform was detected, the MCL reflects 80 ug/L.

ft = feet
HQ = hazard quotient
SVOCs = Semi-volatile organic compounds
VOCs = Volatile organic compounds
NA = Not analyzed
J = The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.
K = The analyte was positively identified, but the associated numerical value may be biased high.
L = The analyte was positively identified, but the associated numerical value may be biased low.
U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.
UJ = The analyte was below the reported sample quantitation limit. However, the reported value is approximate.
UL = The analyte was analyzed for but was not detected. The quantitation limit may be biased low.
ug/l = Micrograms per Liter
Shaded results indicate concentrations detected above the MCL/RSL screening criteria
Italicized results indicate concentrations detected above residential VI SLs based on target risk = 1E-06 / HQ = 0.1
Bold results indicate concentrations detected above commercial / industrial VI SLs based on target risk = 1E-06 / HQ = 0.1

Table 2
Deep Groundwater Data Compared to Screening Criteria
East Property Boundary Investigation at West Virginia Department of Administration Property Technical Memorandum
Bayer CropScience Institute Facility, Institute, West Virginia

	Location	INS-0385	INS-0387				INS-0388		INS-0389		INS-0390	
	Sample ID	0385-GW02-031513	0387-GW02-031413	0387-GW02-031413D	0387-GW-051613	0387-GW-051613D	0388-GW02-031413	0388-GW-051713	0389-GW02-031313	0389-GW-051613	0390-GW02-031213	0390-GW-051713
	Sample Depth (ft)	37 - 42	40 - 45	40 - 45	35 - 45	35 - 45	42 - 47	33.5 - 43.5	42 - 47	35 - 45	42 - 47	35 - 45
	Sample Date	3/15/2013	3/14/2013	3/14/2013	5/16/2013	5/16/2013	3/14/2013	5/17/2013	3/13/2013	5/16/2013	3/12/2013	5/17/2013
Analyte	**MCL/RSL[a]**											
SVOCs (ug/L)												
Isophorone	67	5.26 U	5.49 U	5.62 U	- -	- -	5.43 U	- -	5.38 U	- -	5.15 U	- -
Naphthalene	0.14	5.26 U	5.49 U	5.62 U	- -	- -	5.43 U	- -	5.38 U	- -	5.15 U	- -
VOCs (ug/L)												
1,1-Dichloroethane	2.4	3.58	1.26	1.24	1 U	1 U	1.76	1 U	12.3	6.18	1.51	2.86
1,1-Dichloroethene	7	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1.15	1.03	1 U	1.4
1,2-Dichloroethane	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
1,4-Dioxane (p-Dioxane)	0.67	11.6	1.1 UJ	1.12 UJ	- -	- -	5.46 J	- -	4.63 J	- -	36.7	- -
Acetone	1,200	5 U	5 UL	5 UL	5 UL	5 UL	5 U	5 U	5 U	5 U	5 U	5 U
Benzene	5	1 U	1 U	1 U	1 U	1 U	5.3	1 U	1 U	1 U	1 U	1.67
Chlorobenzene	100	1 U	1 U	1 U	1 U	1 U	1 U	205	1 U	1 U	1 U	37.7
Chloroform	80	24.6	1.78	1.56	1 U	1 U	29.9	2.25	13.8	29.6	1 U	13
Dichlorodifluoromethane	19	2.09	1 U	1 U	1 UJ	1 UJ	1 U	1 U	57.2 L	43 K	1 UJ	1 U
Ethylbenzene	700	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Tetrachloroethene	5	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Toluene	1,000	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Trichlorofluoromethane	110	52.1	2.29	2.05	1 U	1 U	49.5	3.11	25.6 L	141	1 U	30.5
VOCs, Total	--	94.37	5.33	4.85	0 U	0 U	91.92	210.36	114.88	220.81	38.21	87.23

Notes:

[a] Maximum Contaminant Level (MCL) (USEPA 2013a), where available, or USEPA Regional Screening Level (RSL) (USEPA 2013a) for tap water based on a target carcinogenic risk = 1E-06 and a target non-cancer hazard index (HI) = 0.1.

*The listed MCL (80 ug/L) is applied to the sum of four trihalomethanes (bromodichloromethane, bromoform, dibromochloromethane, and chloroform) as an annual average as discussed in the National Primary Drinking Water Standards (USEPA 2009) available at: http://water.epa.gov/drink/contaminants/index.cfm#List. As only chloroform was detected, the MCL reflects 80 ug/L.

ft = feet

SVOCs = Semi-volatile organic compounds

VOCs = Volatile organic compounds

NA = Not analyzed

J = The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.

L = The analyte was positively identified, but the associated numerical value may be biased low.

U = The analyte was analyzed for, but was not detected above the reported sample quantitation limit.

UJ = The analyte was below the reported sample quantitation limit. However, the reported value is approximate.

UL = The analyte was analyzed for but was not detected. The quantitation limit may be biased low.

-- = The analyte was not sampled at this depth interval.

ug/l = Micrograms per Liter

Shaded results indicate concentrations detected above the MCL/RSL screening criteria

Figures

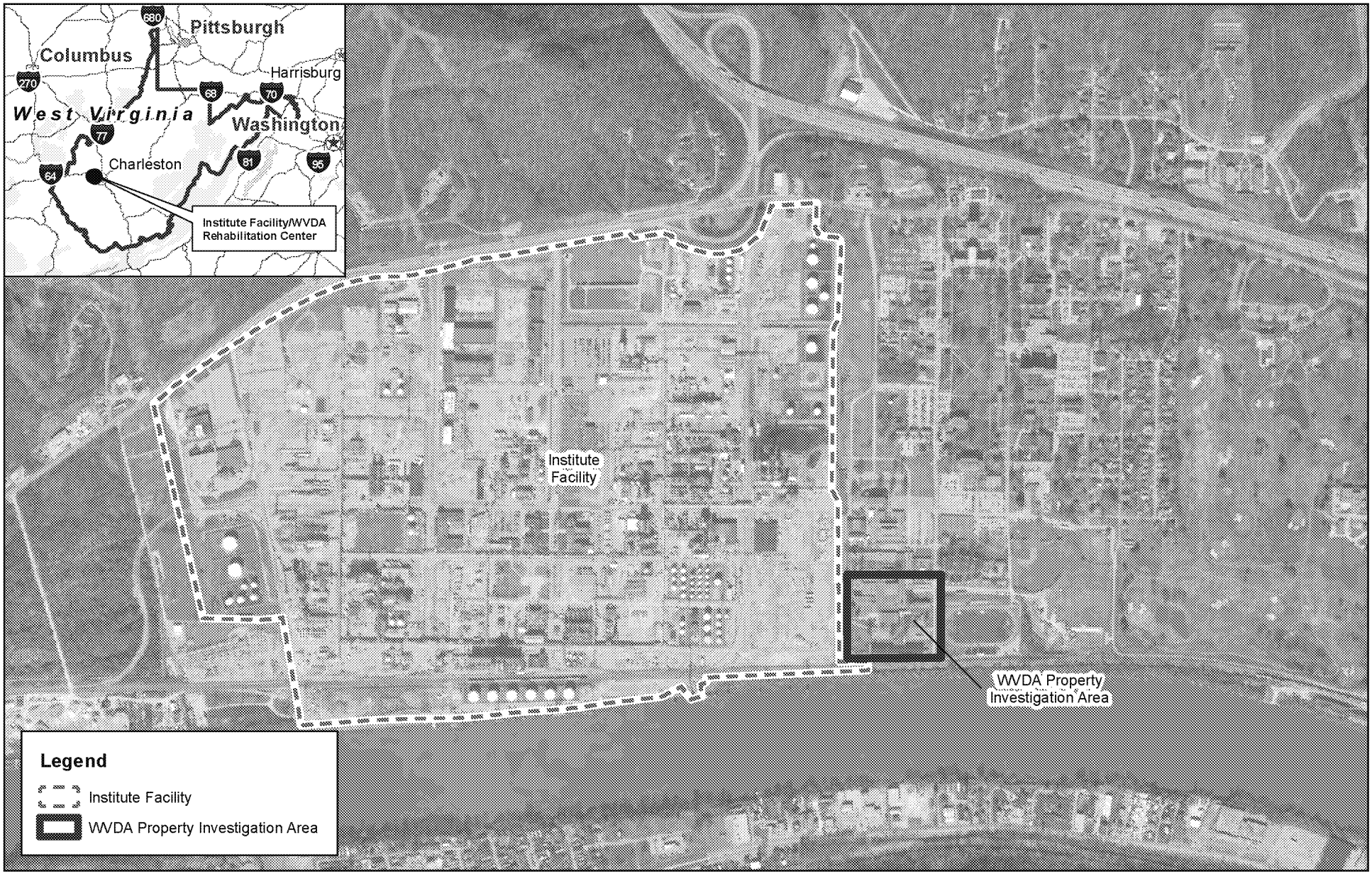


Figure 1
Site Map
East Property Boundary Investigation
Bayer CropScience Institute Facility
Institute, West Virginia

CH2MHILL

MKE \\LAKEFRONT\PROJ\GIS\DOW\INSTITUTE\REPORTS\2012\MISCREQUESTS\MAPFILES\NARENDRA_073012\FIGURE 01 - EAST PROPERTY OFFSITE INVESTIGATION_REV041913.MXD MPETERSH 7/11/2013 3:30:09 PM

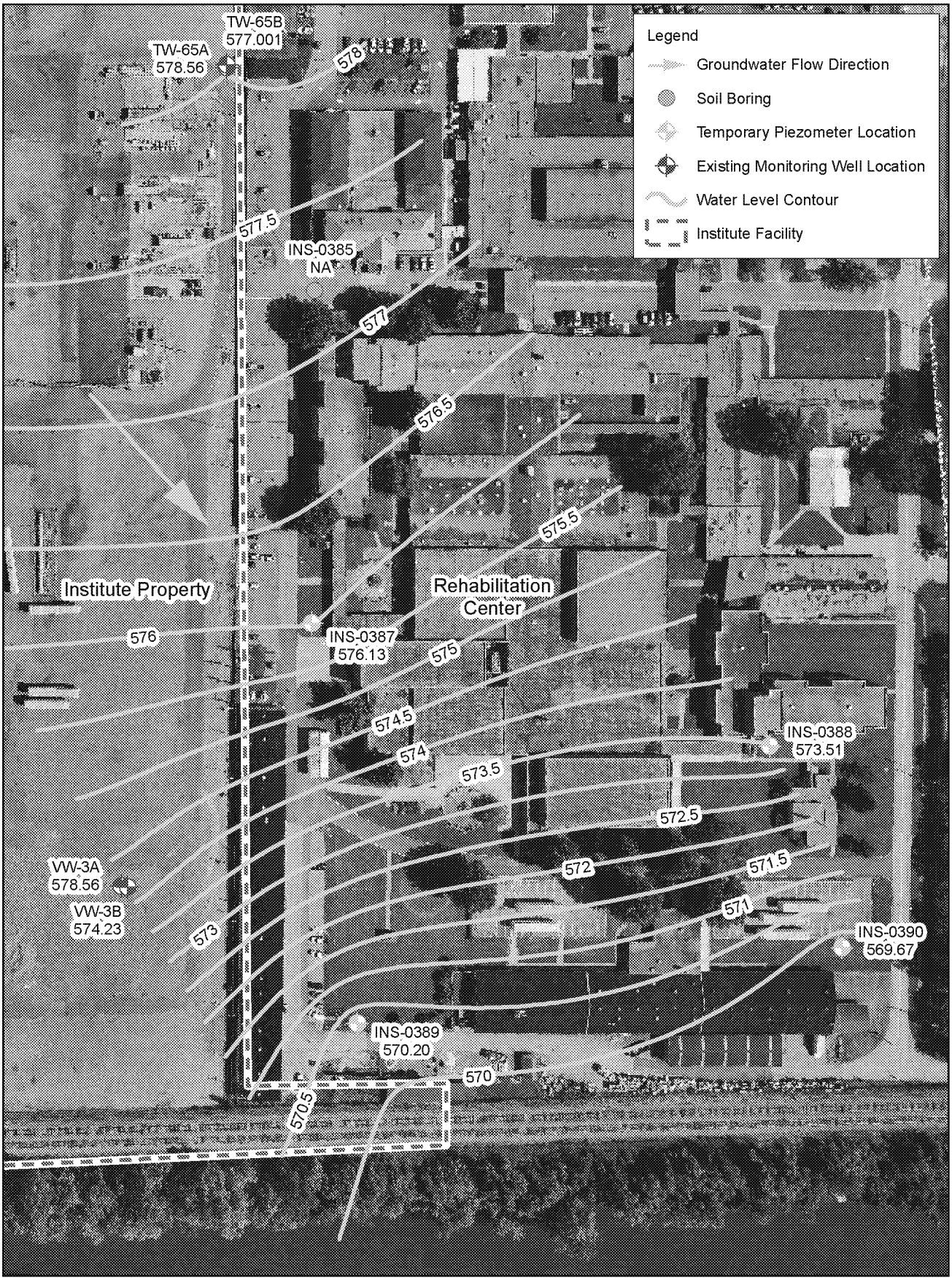


Figure 2
East Property Boundary Investigation
April 17, 2013
Bayer CropScience Institute Facility
Institute, West Virginia

E:\GIS\DOW\INSTITUTE\REPORTS\2013\EASTPROPERTYBOUNDARYINVESTIGATION\MAPFILES\FIGURE 02 - EAST PROPERTY OFFSITE INVESTIGATION - POT MAP APRIL 2013.MXD MPETERSH 7/12/2013 9:27:50 AM

CH2MHILL

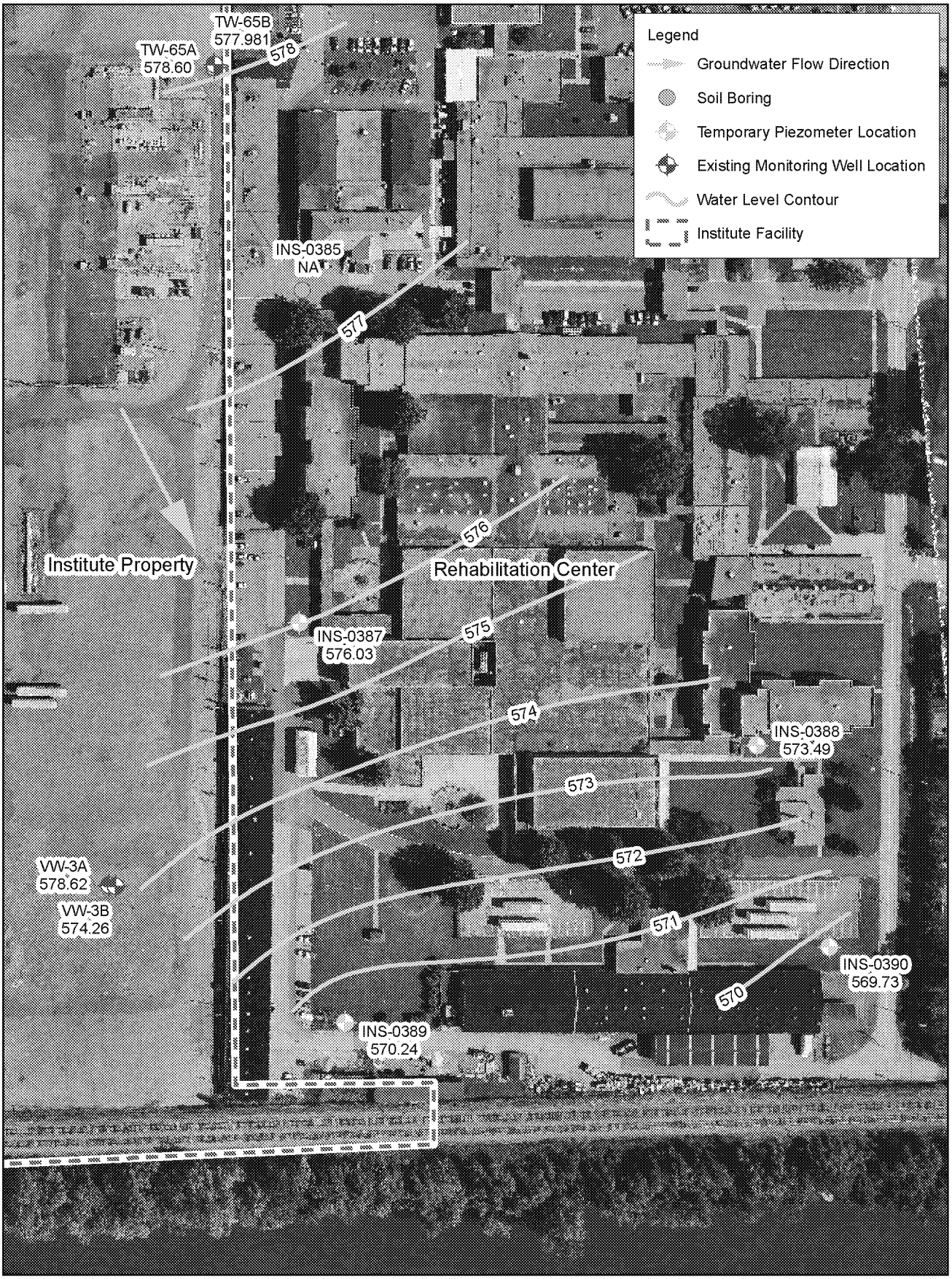
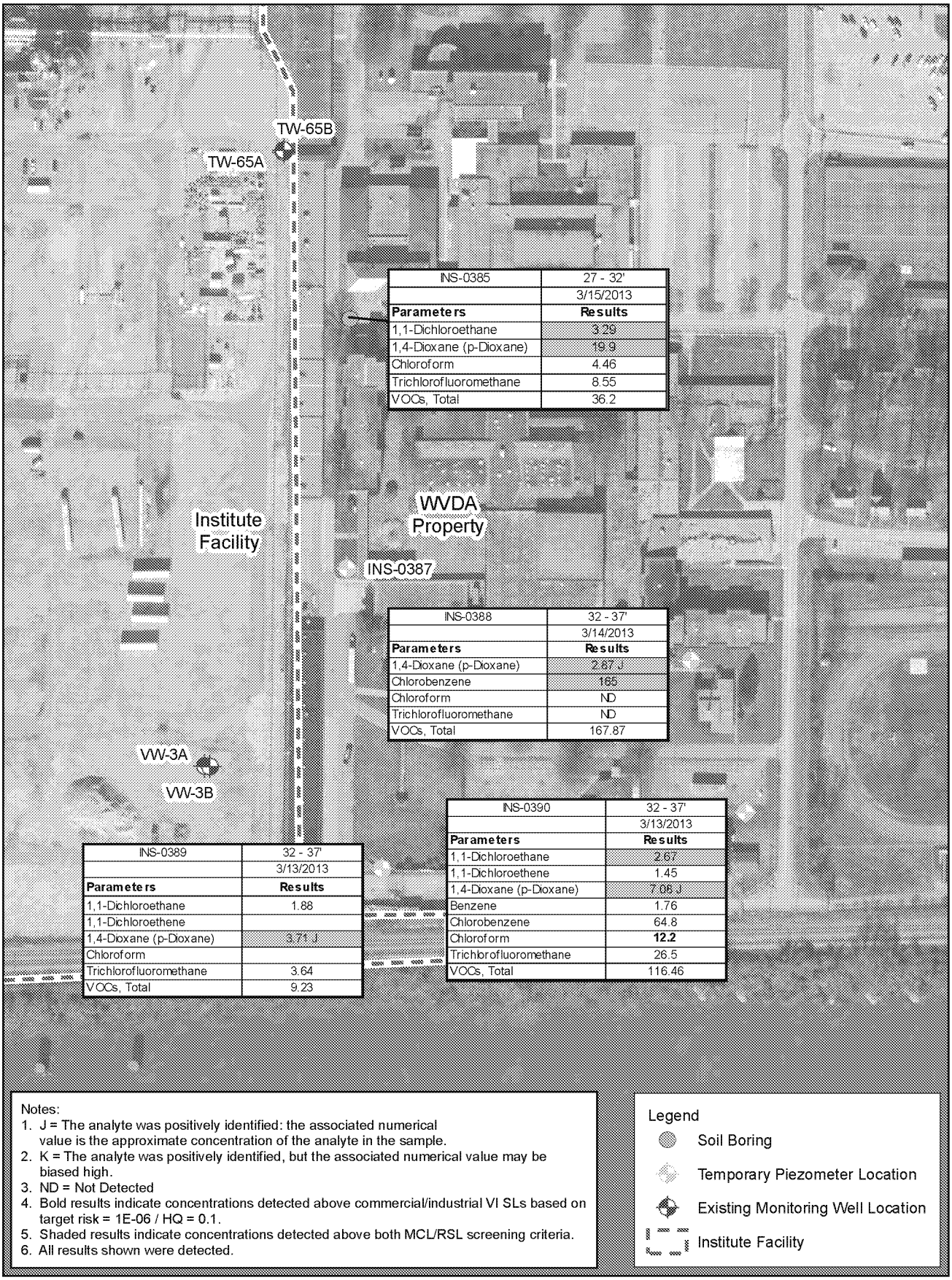


Figure 3
East Property Boundary Investigation
May 24, 2013
Bayer CropScience Institute Facility
Institute, West Virginia

E:\GIS\DOW\INSTITUTE\REPORTS\2013\EASTPROPERTYBOUNDARYINVESTIGATION\MAPFILES\FIGURE 03 - EAST PROPERTY OFFSITE INVESTIGATION - POT MAP MAY 2013.MXD MPETERSH 7/12/2013 10:59:18 AM

CH2MHILL



INS-0385	27 - 32'
	3/15/2013
Parameters	**Results**
1,1-Dichloroethane	3.29
1,4-Dioxane (p-Dioxane)	19.9
Chloroform	4.46
Trichlorofluoromethane	8.55
VOCs, Total	36.2

INS-0388	32 - 37'
	3/14/2013
Parameters	**Results**
1,4-Dioxane (p-Dioxane)	2.67 J
Chlorobenzene	165
Chloroform	ND
Trichlorofluoromethane	ND
VOCs, Total	167.87

INS-0389	32 - 37'
	3/13/2013
Parameters	**Results**
1,1-Dichloroethane	1.88
1,1-Dichloroethene	
1,4-Dioxane (p-Dioxane)	3.71 J
Chloroform	
Trichlorofluoromethane	3.64
VOCs, Total	9.23

INS-0390	32 - 37'
	3/13/2013
Parameters	**Results**
1,1-Dichloroethane	2.67
1,1-Dichloroethene	1.45
1,4-Dioxane (p-Dioxane)	7.06 J
Benzene	1.76
Chlorobenzene	64.8
Chloroform	**12.2**
Trichlorofluoromethane	26.5
VOCs, Total	116.46

Notes:
1. J = The analyte was positively identified: the associated numerical value is the approximate concentration of the analyte in the sample.
2. K = The analyte was positively identified, but the associated numerical value may be biased high.
3. ND = Not Detected
4. Bold results indicate concentrations detected above commercial/industrial VI SLs based on target risk = 1E-06 / HQ = 0.1.
5. Shaded results indicate concentrations detected above both MCL/RSL screening criteria.
6. All results shown were detected.

Legend
- Soil Boring
- Temporary Piezometer Location
- Existing Monitoring Well Location
- Institute Facility

N

0 150 300

Feet

Figure 4
East Property Boundary Investigation
Shallow Groundwater Analytical Results
Bayer CropScience Institute Facility
Institute, West Virginia

E:\GIS\DOW\INSTITUTE\REPORTS\2013\EASTPROPERTYBOUNDARYINVESTIGATION\MAPFILES\FIGURE 04 - EAST PROPERTY INVESTIGATION - SHALLOWGWANALYTICALRESULTS.MXD MPETERSH 7/12/2013 9:53:30 AM

CH2MHILL

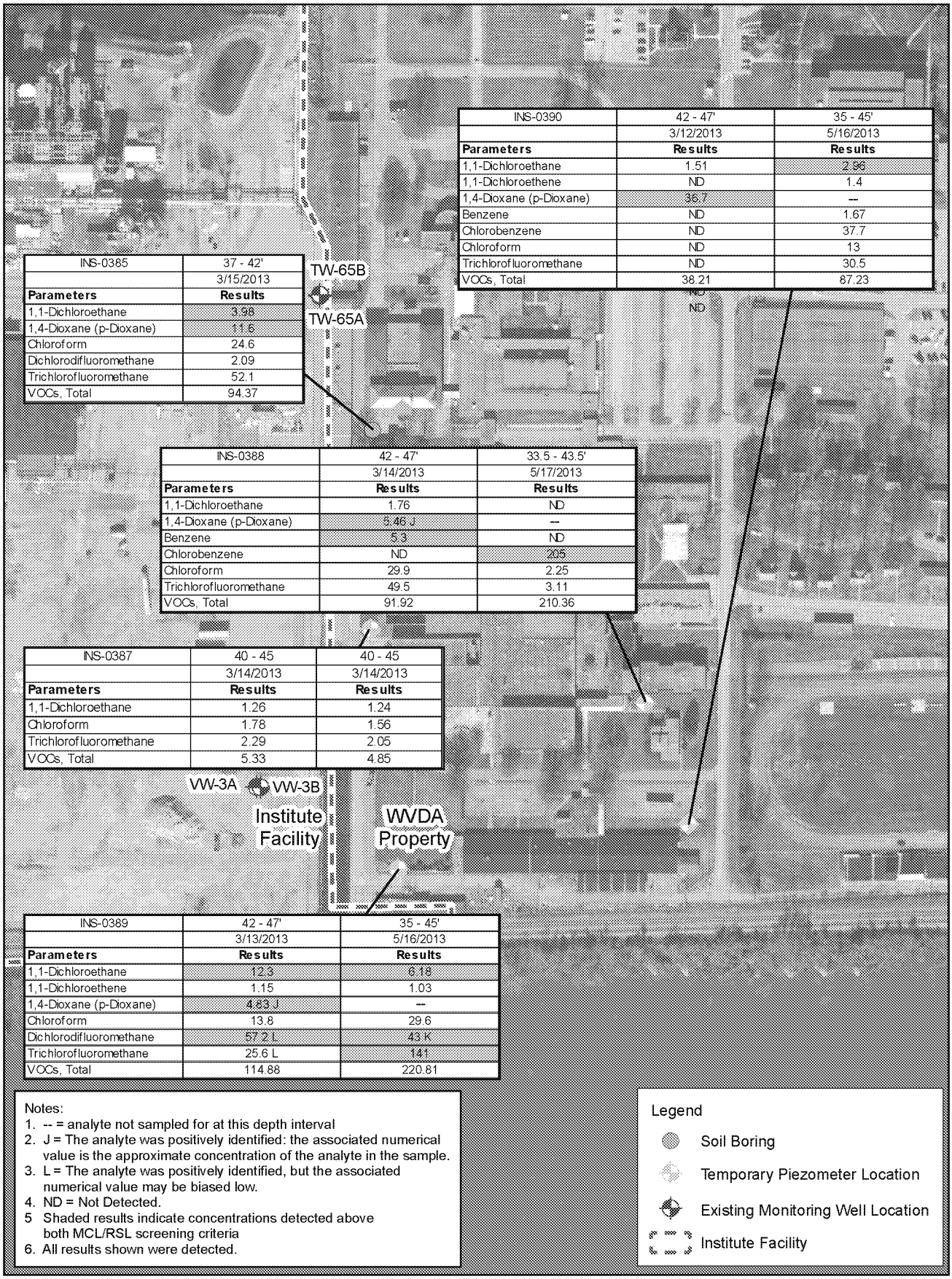


Figure 5
East Property Boundary Investigation
Deep Groundwater Analytical Results
Bayer CropScience Institute Facility
Institute, West Virginia

E:\GIS\DOW\INSTITUTE\REPORTS\2013\EASTPROPERTYBOUNDARYINVESTIGATION\MAPFILES\FIGURE 05 - EAST PROPERTY INVESTIGATION - DEEPGWANALYTICALRESULTS.MXD MPETERSH 7/11/2013 4:27:18 PM

CH2MHILL

Attachment 1

Analytical Laboratory Reports (Presented on CD)

Attachment 2

DQE Validation Memorandum

Data Quality Evaluation for East Boundary Groundwater Investigation, UCC Dow Institute Site, West Virginia

PREPARED FOR: Union Carbide Corporation

PREPARED BY: CH2M HILL

DATE: April 2013

Introduction

The objective of this data quality evaluation (DQE) report is to assess the data quality of analytical results for groundwater collected from the East Boundary of the Union Carbide Corporation (UCC) Dow WVO Institute site in South Charleston, West Virginia (UCC is a wholly owned subsidiary of The Dow Chemical Company). CH2M HILL collected samples March 12-15 and May 16-17, 2013. Guidance for this DQE report came from the *Dow WVO Quality Assurance Project Plan (May 2012)* (Dow WVO QAPP); the *U.S. Environmental Protection Agency (USEPA) Contract Laboratory National Functional Guidelines (NFG) for Organic Review, October 1999;* and individual method requirements.

The analytical results were evaluated using the criteria of precision, accuracy, representativeness, comparability and completeness (PARCC) as presented in the Dow WVO QAPP. This report is intended as a general data quality assessment designed to summarize data issues.

Analytical Data

This DQE report covers 14 groundwater samples, 2 field duplicates (FD) and 6 trip blanks (TB). The samples were reported in six sample delivery groups identified as: L13030488, L13030536, L13030581, L13030596, L13050932 and L13051018. Samples were collected and delivered to Microbac Laboratories, Inc (MBLM) in Marietta, Ohio. The samples were analyzed by one or more of the methods listed in Table 1.

TABLE 1
Analytical Parameters
Institute East Boundary Groundwater Investigation, Dow West Virginia

Parameter	Method	Laboratory
Volatile Organic Compounds (VOC)	SW8260B	MBLM
Semivolatile Organic Compounds (SVOC)	SW8270C/SW8270 SIM	MBLM

The sample delivery groups were assessed by reviewing the following: 1) the chain of custody documentation; 2) holding-time compliance; 3) initial and continuing calibration criteria; 4) method blanks/field blanks; 5) laboratory control spiking sample/laboratory control spiking sample duplicate (LCS/LCSD) recoveries; 6) matrix spike/matrix spike duplicate (MS/MSD) recoveries; 7) surrogate

spike recoveries; 8) FD precision; 9) internal standard (IS) recoveries; and 10) the required quality control (QC) samples at the specified frequencies.

Data flags were assigned according to the Dow WVO QAPP. Multiple flags are routinely applied to specific sample method/matrix/analyte combinations, but there will only be one final flag. A final flag is applied to the data and is the most conservative of the applied validation flags. The final flag also includes matrix and blank sample impacts.

The data flags are those listed in the Dow WVO QAPP and are defined below:

- J = The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- R = The sample result was rejected due to serious deficiencies in the ability to analyze the sample and meet the QC criteria. The presence or absence of the analyte could not be verified.
- U = The analyte was analyzed for but was not detected above the reported sample quantitation limit.
- UJ = The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- B = The analyte was detected in the blank as well as the samples.
- K = The analyte was positively identified, but the associated numerical value may be biased high.
- L = The analyte was positively identified, but the associated numerical value may be biased low.
- UL = The analyte was analyzed for but was not detected. The quantitation limit may be biased low.

Findings

The overall summaries of the data validation are contained in the following sections. Qualified data are listed in Table 2.

Holding Time/Preservation

All acceptance criteria were met.

Calibration

Initial and continuing calibration analyses were performed as required by the methods and all acceptance criteria were met with the following exceptions:

The percent difference (%D) for acetone was less than method criteria in one VOC initial calibration verification standard (ICVS), indicating a possible low sample bias. The data were qualified as estimated non-detects and flagged "UJ" in the associated samples.

The %D for dichlorodifluoromethane was greater than method criteria in a few VOC initial ICVS, indicating a possible high sample bias. Detected results were qualified as estimated and flagged "J" in the associated samples. Non-detected results were not qualified. There were a few instances where the %D for dichlorodifluoromethane was significantly greater than criteria. In thes instances, the non-detected results were qualified as estimated and flagged "UJ" in the associated samples.

The %D for acetone was less than method criteria in one VOC CCV, indicating a possible low sample bias. The data were qualified as estimated non-detects and flagged "UJ" in the associated samples. In addition, the %Ds for dichlorodifluoromethane and/or trichlorofluoromethe were greater than criteria in a few VOC continuing calibration verification standards (CCV), indicating a possible high bias. The data were not qualified because the associated samples did not contain reportable levels of these analytes.

The relative response factor (RRF) for acetone was less than criteria in a few VOC CCVs, indicating a possible low bias. The data were qualified as estimated non-detected results and flagged "UL" in the associated samples.

The %D for 1,4-dioxane was less than criteria in a few SVOC SIM ICVSs, indicating a possible low sample bias. The data were qualified as estimated non-detected results and flagged "UJ" in the associated samples.

Method Blanks

Method blanks were analyzed at the required frequency and were free of contamination.

Laboratory Control Samples

LCS/LCSDs were analyzed as required and all accuracy and precision criteria were met with the following exceptions:

Dichlorodifluoromethane was recovered greater than the upper control limit in a few VOC LCS/LCSDs, indicating a possible high sample bias. Detected results were qualified as estimated and flagged "K" in the associated samples. Non-detected results were not qualified. There was one instance where dichlorodifluoromethane recovered greater than 200 percent in the VOC LCS/LCSD, indicating a possible significant high bias. The result was qualified as an estimated non-detect and flagged "UJ" in the associated sample.

Naphthalene was recovered greater than the upper control limit in a few SVOC LCS/LCSDs, indicating a possible high bias. The data were not qualified because the associated samples did not contain reportable levels of naphthalene.

Matrix Spike

MS/MSD samples were analyzed as required and all accuracy and precision criteria were met with the following exceptions:

Dichlorofluoromethane and trichlorofluoromethane were recovered less than the lower control limits in the VOC MS/MSD for sample 0389-GW02-031313, indicating a possible low bias. The data were qualified as estimated detected results and flagged "L" in the sample.

Naphthalene was recovered greater than the upper control limit in the SVOC MS/MSD for sample 0389-GW02-031313, indicating a possible high bias. The data were not qualified because the parent sample did not contain a reportable level of naphthalene.

Internal Standards

ISs were added to all samples and all acceptance criteria were met.

Surrogates

Surrogates were added to all samples for methods requiring their use and all acceptance criteria were met.

Field Duplicates

A FD was collected as required and all precision criteria were met.

Field Blanks

TBs were collected, analyzed and were free of contamination.

Chain of Custody

Required procedures were followed and were generally free of errors.

Overall Assessment

The goal of this assessment is to demonstrate that a sufficient number of representative samples were collected and the resulting analytical data can be used to support the decision- making process. The following summary highlights the PARCC findings for the above-defined events:

Precision of the data was verified through the review of the field and laboratory data quality indicators that include: FD, LCS/LCSD and MS/MSD RPDs. Precision was acceptable.

Accuracy of the data was verified through the review of the calibration data, LCS/LCSD, MS/MSD, internal standards and surrogate standard recoveries, as well as the evaluation of method/field blank data. Accuracy was generally acceptable with the exception of a few analytes being qualified as estimated detected and non-detected results due to calibration, LCS/LCSD and/or MS/MSD issues. All method/field blank data were free of contamination. Data users should consider the impact to any result that is qualified as it may contain a bias which could affect the decision-making process.

Representativeness of the data was verified through the sample's collection, storage and preservation procedures and the verification of holding-time compliance. No issues were noted due to sample collection, storage or preservation procedures. All data were reported from analyses within the USEPA recommended holding time.

Comparability of the data was verified through the use of standard USEPA analytical procedures and standard units for reporting. Results obtained are comparable to industry standards in that the collection and analytical techniques followed approved, documented procedures.

Completeness is a measure of the number of valid measurements obtained in relation to the total number of measurements planned. Completeness is expressed as the percentage of valid or usable measurements compared to planned measurements. Valid data are defined as all data that are not rejected for project use. All data were considered valid. The completeness goal of 90 percent was met for all method/analytes combinations. The data can be used for project decisions taking into consideration the validation flags applied to the data.

TABLE 2

Qualified Data

Institute East Boundary Groundwater Investigation, Dow West Virginia

NativeID	Method	Analyte	Units	Final Result	Validation Flag	Validation Reason
0387-GW01-031413	SW8270SIM	1,4-Dioxane	ug/L	1.1	UJ	ICVS<LCL
0387-GW01-031413	SW8260B	Acetone	ug/L	5	UL	CCV RRF
0387-GW02-031413	SW8270SIM	1,4-Dioxane	ug/L	1.1	UJ	ICVS<LCL
0387-GW02-031413	SW8260B	Acetone	ug/L	5	UL	CCV RRF
0387-GW02-031413D	SW8270SIM	1,4-Dioxane	ug/L	1.12	UJ	ICVS<LCL
0387-GW02-031413D	SW8260B	Acetone	ug/L	5	UL	CCV RRF
0387-GW-051613	SW8260B	Acetone	ug/L	5	UL	CCV RRF, CCV<LCL (UJ), ICVS<LCL (UJ)
0387-GW-051613	SW8260B	Dichlorodifluoromethane	ug/L	1	UJ	ICVS>UCL
0387-GW-051613D	SW8260B	Acetone	ug/L	5	UL	CCV RRF, CCV<LCL (UJ), ICVS<LCL (UJ)
0387-GW-051613D	SW8260B	Dichlorodifluoromethane	ug/L	1	UJ	ICVS>UCL
0388-GW01-031413	SW8270SIM	1,4-Dioxane	ug/L	2.87	J	ICVS<LCL
0388-GW02-031413	SW8270SIM	1,4-Dioxane	ug/L	5.46	J	ICVS<LCL
0389-GW01-031313	SW8270SIM	1,4-Dioxane	ug/L	3.71	J	ICVS<LCL
0389-GW02-031313	SW8270SIM	1,4-Dioxane	ug/L	4.83	J	ICVS<LCL
0389-GW02-031313	SW8260B	Dichlorodifluoromethane	ug/L	57.2	L	MS<LCL, ICVS>UCL (J)
0389-GW02-031313	SW8260B	Trichlorofluoromethane	ug/L	25.6	L	MS<LCL
0389-GW-051613	SW8260B	Dichlorodifluoromethane	ug/L	43	K	LCS>UCL, ICVS>UCL (J)
0390-GW01-031213	SW8270SIM	1,4-Dioxane	ug/L	7.08	J	ICVS<LCL
0390-GW02-031213	SW8260B	Dichlorodifluoromethane	ug/L	1	UJ	ICVS>UCL, LCS>UCL, LCSD>UCL

Validation Reasons:

CCV RRF	The continuing calibration verification relative response factor was less than method criteria
CCV<LCL	The initial calibration verification was recovered less than method criteria
ICVS<LCL	The initial calibration verification was recovered less than method criteria
ICVS>UCL	The initial calibration verification was recovered greater than method criteria
LCS>UCL	The laboratory control sample was recovered greater than the upper control limit
LCSD>UCL	The laboratory control sample duplicate was recovered greater than the upper control limit
MS<LCL	The matrix spike was recovered less than the lower control limit

Attachment 3

Boring Logs and Piezometer Construction Logs

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
435188	0387 SHEET 1 OF 3

SOIL BORING LOG

PROJECT : East Property Boundary — LOCATION : Institute, WV

ELEVATION : — DRILLING CONTRACTOR : Subsurface

DRILLING METHOD AND EQUIPMENT : DPT Powerprobe 9500 VTR

WATER LEVELS : --- — START : 3/13/13 14:15 — END : 3/15/13 16:30 — LOGGER : D. Roberts

DEPTH BELOW SURFACE AND ELEVATION (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	SAMPLER (TYPE)	SOIL DESCRIPTION: DEPTH INTERVAL, SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
		0.0 / 5.0	MC1	**Fill** 0.0-5.0' - Air knife 0-4' - Silty Clay, dry to moist, brown 4-5' - Silty material, gray, white and black specs, no odor				J-plug
5	5.0							
		5.0 / 5.0	MC2	**Fill** 5.0-8.0' - gray and black material, silty, white specs, wet, soft, wet looks metallic, no odor		0.2 0.3 0.3	Collected Soil Sample: 0387-SO01-031313 at 5.5-6.0' for VOCs and SVOCs	
				Gravelly Clay (CL) 8.0-13.5' - light brown and gray mottled, moist to dry, soft, clay with little gravel		0.3 0.1		
10	10.0							2.75" - schedule 40 PVC 1"
		3.5 / 5.0	MC3			0.4 0.1 0		
				13.5-15.0' - no recovery				
15	15.0							
		2.5 / 5.0	MC4	**Clay (CL)** 15.0-17.5' - light brown and gray mottled, dry, stiff to very stiff		0.4 0 0		Bentonite Chips
				17.5-20.0' - no recovery				
20	20.0							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
435188	0387 SHEET 2 OF 3

SOIL BORING LOG

PROJECT : East Property Boundary LOCATION : Institute, WV

ELEVATION : DRILLING CONTRACTOR : Subsurface

DRILLING METHOD AND EQUIPMENT : DPT Powerprobe 9500 VTR

WATER LEVELS : --- START : 3/13/13 14:15 END : 3/15/13 16:30 LOGGER : D. Roberts

DEPTH BELOW SURFACE AND ELEVATION (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	SAMPLER (TYPE)	SOIL DESCRIPTION: DEPTH INTERVAL, SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
	20.0			**Sandy Clay (CL)** 20.0-20.5' - brown, moist, soft, clay with some sand		0.2		
				Silty Sandy Clay (CL) 20.5-22.0' - brown, moist, soft, clay with some silt and little fin grained sand		0.3		
		4.5/5.0	MC5	**Silty Clay (CL)** 22.0-24.0' - brown, moist, medium stiff, clay with little silt, micaceous		0		
						0		
				Silty Sandy Clay (CL) 24.0-24.5' - brown, moist, soft, clay with some silt and little fine grained sand				
25	25.0			24.5-25.0' - no recovery				
				Silty Sand (SM) 25.0-25.5' - dark brown, wet, loose, sand with some silt, fine to medium grained, poorly graded		0.2		
				Silty Clay (CL) 25.5-27.5' - brown, moist, medium stiff, clay with little silt		0.2		
		4.5/5.0	MC6	**Clayey Sand (SC)** 27.5-29.5' - brown, moist to wet, medium dense, sand with little clay, fine grained, poorly graded		0.1		
						0		
30	30.0			29.5-30.0' - no recovery				
				Clayey Sand (SC) 30.0-31.0' - brown, wet, medium dense, sand with little clay, fine grained, poorly graded		0		
				Silty Sand (SM) 31.0-33.0' - gray, wet, loose, sand with some silt, fine grained, poorly graded		0.2		
		4.0/5.0	MC7			0		
				Silty Sand (SM) 33.0-34.0' - brownish orange, wet, loose, sand with some silt, medium grained, poorly graded		0		
				34.0-35.0' - no recovery				
35	35.0							
				Silty Sand (SM) 35.0-39.5' - brownish orange, wet, loose, sand with little silt, medium grained, poorly graded		0.1		10 slot
		4.5/5.0	MC8			0		
						0		
						0		Sand
40	40.0			39.5-40.0' - no recovery				

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
435188	0387 SHEET 3 OF 3

SOIL BORING LOG

PROJECT : East Property Boundary LOCATION : Institute, WV

ELEVATION : DRILLING CONTRACTOR : Subsurface

DRILLING METHOD AND EQUIPMENT : DPT Powerprobe 9500 VTR

WATER LEVELS : --- START : 3/13/13 14:15 END : 3/15/13 16:30 LOGGER : D. Roberts

DEPTH BELOW SURFACE AND ELEVATION (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	SAMPLER (TYPE)	SOIL DESCRIPTION: DEPTH INTERVAL, SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
	40.0			**Silty Sand (SM)** 40.0-44.5' - brownish orange, wet, loose, sand with little silt, medium grained		0.1 0.1 0.1 0.1		
		4.5 5.0	MC9					
45	45.0			44.5-45.0' - no recovery				
				Sand (SP) 45.0-49.0' - brown, wet, loose, poorly graded, medium grained		0.1 0.2 0.1		
		4.0 5.0	MC10					
50	50.0			49.0-50.0' - no recovery				
				Bottom of Boring at 50.0 ft below ground surface				
55								
60								

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
435188	0388 SHEET 1 OF 3

SOIL BORING LOG

PROJECT : East Property Boundary LOCATION : Institute, WV

ELEVATION : DRILLING CONTRACTOR : Subsurface

DRILLING METHOD AND EQUIPMENT : DPT Powerprobe 9500 VTR

WATER LEVELS : --- START : 3/14/13 11:30 END : 3/14/13 13:30 LOGGER : D. Roberts

DEPTH BELOW SURFACE AND ELEVATION (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	SAMPLER (TYPE)	SOIL DESCRIPTION: DEPTH INTERVAL, SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
		0.0 / 5.0	MC1	**Silty Clay (CL)** 0.0-5.0' - black and brown, moist to dry, Air knife				J-plug
5	5.0							
		4.0 / 5.0	MC2	**Gravelly Silty Clay (CL)** 5.0-6.0' - brown, dry, stiff, clay with some gravel and some silt		0		
				Fill 6.0-9.0' - silty fine grained non native material, includes white specs and some black specs in layers, wet		0.1 0.1 0.2		
				9.0-10.0' - no recovery		0.1		
10	10.0							2.75" - schedule 40 PVC 1"
		5.0 / 5.0	MC3	**Fill** 10.0-11.5' - silty fine grained non native material, includes white specs and some black specs in layers, wet		0		
				Silty Gravelly Clay (CL) 11.5-15.0' - brown and gray mottled, dry to moist, stiff, clay with little silt and trace (small) gravel		0.1 0 0 0		
15	15.0							
		2.5 / 5.0	MC4	**Silty Clay (CL)** 15.0-17.5' - brown, dry, very stiff, clay with trace silt		0 0		Bentonite Chips
				17.5-20.0' - no recovery				
20	20.0							

CH2MHILL

PROJECT NUMBER: 435188	BORING NUMBER: 0388 SHEET 2 OF 3

SOIL BORING LOG

PROJECT : East Property Boundary LOCATION : Institute, WV

ELEVATION : DRILLING CONTRACTOR : Subsurface

DRILLING METHOD AND EQUIPMENT : DPT Powerprobe 9500 VTR

WATER LEVELS : --- START : 3/14/13 11:30 END : 3/14/13 13:30 LOGGER : D. Roberts

DEPTH BELOW SURFACE AND ELEVATION (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	SAMPLER (TYPE)	SOIL DESCRIPTION: DEPTH INTERVAL, SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
	20.0			**Clayey Silt (ML)** 20.0-21.5' - brown, dry to moist, stiff, silt with some clay		0		
		3.5 5.0	MC5	**Sandy Silt (ML)** 21.5-25.5' - brown, moist, soft to medium stiff, silt with little fine grained sand		0 0 0		
25	25.0			**Clayey Sand (SC)** 25.5-27.0' - brown, wet, loose, sand with some clay, fine grained, poorly graded		0 0		
		4.0 5.0	MC6	**Silty Sand (SM)** 27.0-29.0' - brown, wet, medium dense, sand and silt, fine grained, poorly graded		0 0		
30	30.0			29.0-30.0' - no recovery		0		
		4.5 5.0	MC7	**Sandy Clay (CL)** 30.0-32.5' - brown to brownish gray toward 32', wet, medium stiff, clay with little fine grained sand		0 0 0		
				Clayey Sand (SC) 32.5-34.0' - brown and gray, wet, medium dense to loose, sand with some clay, fine grained, poorly graded		0 0		
35	35.0			**Silty Sand (SM)** 34.0-34.5' - brown and orange layers, wet, medium dense, sand with little silt, medium grained, poorly graded				10 slot
				34.5-35.0' - no recovery		0		
		3.0 5.0	MC8	**Silty Sand (SM)** 35.0-50.0' - brown, wet, medium dense, sand with little silt, medium grained, poorly graded, sandstone at 36.5' and 38.0'		0 0 0 0		Sand
40	40.0					0		

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
435188	0388 SHEET 3 OF 3

SOIL BORING LOG

PROJECT : East Property Boundary LOCATION : Institute, WV

ELEVATION : DRILLING CONTRACTOR : Subsurface

DRILLING METHOD AND EQUIPMENT : DPT Powerprobe 9500 VTR

WATER LEVELS : --- START : 3/14/13 11:30 END : 3/14/13 13:30 LOGGER : D. Roberts

DEPTH BELOW SURFACE AND ELEVATION (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	SAMPLER (TYPE)	SOIL DESCRIPTION: DEPTH INTERVAL, SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
	40.0	5.0 / 5.0	MC9					
45	45.0	5.0 / 5.0	MC10					
50	50.0			Bottom of Boring at 50.0 ft below ground surface				
55								
60								

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
435188	0389 SHEET 1 OF 3

SOIL BORING LOG

PROJECT : East Property Boundary LOCATION : Institute, WV

ELEVATION : DRILLING CONTRACTOR : Subsurface

DRILLING METHOD AND EQUIPMENT : DPT Powerprobe 9500 VTR

WATER LEVELS : --- START : 3/12/13 10:20 END : 3/12/13 12:25 LOGGER : D. Roberts

DEPTH BELOW SURFACE AND ELEVATION (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	SAMPLER (TYPE)	SOIL DESCRIPTION: DEPTH INTERVAL, SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
		0.0 / 5.0	MC1	**Clayey Silt (ML)** 0.0-5.0' - brown, moist, Air knife				J-plug
5	5.0							
		5.0 / 5.0	MC2	**Silty Clay (CL)** 5.0-7.0' - brown and gray mottled, moist, medium stiff, clay with little silt		0 0		
				Silty Clay (CL) 7.0-10.0' - brown, moist, medium stiff to stiff, clay with trace silt		0 0 0		
10	10.0							2.75" - schedule 40 PVC 1"
		5.0 / 5.0	MC3	**Silty Clay (CL)** 10.0-15.0' - brown, moist, stiff, clay with trace silt		0 0 0 0 0		
15	15.0							
		5.0 / 5.0	MC4	**Silty Clay (CL)** 15.0-20.0' - brown, moist to wet, medium stiff, clay with trace silt, micaceous		0 0 0 0 0		Bentonite Chips
20	20.0							

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
435188	0389 SHEET 2 OF 3

SOIL BORING LOG

PROJECT : East Property Boundary LOCATION : Institute, WV

ELEVATION : DRILLING CONTRACTOR : Subsurface

DRILLING METHOD AND EQUIPMENT : DPT Powerprobe 9500 VTR

WATER LEVELS : --- START : 3/12/13 10:20 END : 3/12/13 12:25 LOGGER : D. Roberts

DEPTH BELOW SURFACE AND ELEVATION (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	SAMPLER (TYPE)	SOIL DESCRIPTION: DEPTH INTERVAL, SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
	20.0			**Clay (CL)** 20.0-21.5' - brown, moist to wet, soft		0		
		4.0 5.0	MC5	**Silty Clay (CL)** 21.5-24.0' - brown, moist to wet, medium stiff, clay with little silt		0 0 0		
25	25.0			24.0-25.0' - no recovery				
		4.0 5.0	MC6	**Silty Clay (CL)** 25.0-26.5' - brown, moist to wet, soft, clay with some silt		0		
				Clayey Sand (SC) 26.5-28.0' - brown, moist, medium dense, sand and clay, fine grained, poorly graded		0 0		
				Silty Sand (SM) 28.0-29.0' - brownish orange, moist, dense, sand with some silt, fine grained, poorly graded		0		
30	30.0			29.0-30.0' - no recovery				
		5.0 5.0	MC7	**Silty Sand (SM)** 30.0-31.5' - brown, wet, loose, sand with some silt, fine grained, poorly graded		0	water at 30'	
				Clayey Sand (SC) 31.5-35.0' - gray, moist, medium dense, sand with some clay, fine grained, poorly graded		0 0 0 0		
35	35.0							
		5.0 5.0	MC8	**Organic wood** 35.0-36.5'		0		10 slot
				Sandy Clay (CL) 36.5-37.5' - gray, wet, soft, clay with some sand		0		
				Silty Sand (SM) 37.5-40.5' - brownish orange, wet, loose, sand with little silt, well graded, fine to medium grained with depth		0 0		Sand
40	40.0					0		

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
435188	0389 SHEET 3 OF 3

SOIL BORING LOG

PROJECT : East Property Boundary LOCATION : Institute, WV

ELEVATION : DRILLING CONTRACTOR : Subsurface

DRILLING METHOD AND EQUIPMENT : DPT Powerprobe 9500 VTR

WATER LEVELS : --- START : 3/12/13 10:20 END : 3/12/13 12:25 LOGGER : D. Roberts

DEPTH BELOW SURFACE AND ELEVATION (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	SAMPLER (TYPE)	SOIL DESCRIPTION: DEPTH INTERVAL, SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
	40.0							
		3.0 / 5.0	MC9	**Sand (SP)** 40.5-41.7' - light gray, wet, loose, medium grained, poorly graded		0		
				Sand (SP) 41.7-43.0' - dark orange, wet, medium dense, fine grained, poorly graded		0		
				43.0-45.0' - no recovery		0		
45	45.0							
		3.5 / 5.0	MC10	**Sand (SP)** 45.0-47.5' - brown, wet, medium dense, medium grained, poorly graded		0		
						0		
				Sand (SW) 47.5-48.5' - black, gray, light gray, wet, medium dense, fine to medium grained, well graded		0		
				48.5-50.0' - no recovery			Bedrock at 49.0'	
50	50.0							
				Bottom of Boring at 50.0 ft below ground surface				
55								
60								

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
435188	0390 SHEET 1 OF 3

SOIL BORING LOG

PROJECT : East Property Boundary — LOCATION : Institute, WV

ELEVATION : — DRILLING CONTRACTOR : Subsurface

DRILLING METHOD AND EQUIPMENT : DPT Powerprobe 9500 VTR

WATER LEVELS : --- — START : 3/12/13 14:10 — END : 3/12/13 15:45 — LOGGER : D. Roberts

DEPTH BELOW SURFACE AND ELEVATION (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	SAMPLER (TYPE)	SOIL DESCRIPTION: DEPTH INTERVAL, SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
		0.0 / 5.0	MC1	**Clayey Silt (ML)** 0.0-5.0' - brown, dry to moist, Air knife				J-plug
5	5.0							
		5.0 / 5.0	MC2	**Silty Clay (CL)** 5.0-6.5' - brown and gray mottled, dry to moist, stiff, clay with trace silt, some small black gravel from 5-6'		0		
				Silty Clay (CL) 6.5-14.5' - brown, dry to moist, very stiff, clay with trace silt, micaceous		0		
10	10.0					0		2.75" - schedule 40 PVC 1"
		4.5 / 5.0	MC3			0		
15	15.0			14.5-15.0' - no recovery		0		
		5.0 / 5.0	MC4	**Silty Clay (CL)** 15.0-21.0' - brown, dry to moist, very stiff, clay with trace silt, micaceous		0		Bentonite Chips
20	20.0					0		

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
435188	0390 SHEET 2 OF 3

SOIL BORING LOG

PROJECT : East Property Boundary LOCATION : Institute, WV

ELEVATION : DRILLING CONTRACTOR : Subsurface

DRILLING METHOD AND EQUIPMENT : DPT Powerprobe 9500 VTR

WATER LEVELS : --- START : 3/12/13 14:10 END : 3/12/13 15:45 LOGGER : D. Roberts

DEPTH BELOW SURFACE AND ELEVATION (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	SAMPLER (TYPE)	SOIL DESCRIPTION: DEPTH INTERVAL, SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
	20.0					0		
				Silty Clay (CL) 21.0-22.0' - brown, moist, stiff, clay with little silt		0		
		5.0 5.0	MC5	**Silty Clay (CL)** 22.0-25.0' - brown, moist, soft, clay with little silt		0 0 0		
25	25.0					0		
				Silty Clay (CL) 25.0-26.0' - brown, moist, stiff, clay with little silt		0		
				Silty Sand (SM) 26.0-27.5' - brown, moist, loose, sand with some silt, very fine grained, poorly graded		0		
		2.5 5.0	MC6	27.5-30.0' - no recovery				
30	30.0							
				Silty Clayey Sand (SM & SC) 30.0-33.0' - brown, gray, orange mottled, moist, medium dense to loose, sand with some silt and some clay, fine grained sand, well graded, wet at 30.5'		0 0 0		
		5.0 5.0	MC7	**Silty Sand (SM)** 33.0-35.0' - brown, wet, medium dense, sand with little silt, fine to medium grained, well graded		0 0		
35	35.0					0		
				Silty Sand (SM) 35.0-36.5' - brown and gray, wet, loose, sand with some silt, fine grained, poorly graded		0		10 slot
		4.0 5.0	MC8	**Silty Sand (SM)** 36.5-40.0' - black, gray, brown, wet, loose, sand with little silt, fine to medium grained gradation to depth, well graded, small coal layer at 36.0'		0 0 0		Sand
40	40.0					0		

CH2MHILL

PROJECT NUMBER:	BORING NUMBER:
435188	0390 SHEET 3 OF 3

SOIL BORING LOG

PROJECT : East Property Boundary LOCATION : Institute, WV

ELEVATION : DRILLING CONTRACTOR : Subsurface

DRILLING METHOD AND EQUIPMENT : DPT Powerprobe 9500 VTR

WATER LEVELS : --- START : 3/12/13 14:10 END : 3/12/13 15:45 LOGGER : D. Roberts

DEPTH BELOW SURFACE AND ELEVATION (ft)	SAMPLE INTERVAL (ft)	RECOVERY (ft)	SAMPLER (TYPE)	SOIL DESCRIPTION: DEPTH INTERVAL, SOIL NAME, USCS GROUP SYMBOL, COLOR, MOISTURE CONTENT, RELATIVE DENSITY OR CONSISTENCY, SOIL STRUCTURE, MINERALOGY	GRAPHIC LOG	PID (ppm)	COMMENTS	WELL DIAGRAM
	40.0			**Silty Sand (SM)** 40.0-45.0' - black, brown, orange, wet, loose to medium dense, sand with little silt, well graded, fine to medium grained sand		0		
		5.0/5.0	MC9			0		
						0		
						0		
45	45.0					0		
				Sand (SP) 45.0-47.5' - brown to gray, wet, medium dense, medium grained, poorly graded		0		
		2.5/5.0	MC10			0		
				47.5-50.0' - no recovery				
50	50.0							
				Bottom of Boring at 50.0 ft below ground surface				
55								
60								